Market Fragmentation in eFX

Tom J. Espel

Imperial College London

Wednesday 27th October, 2021

Outline

Foreign Exchange Market

Do you know how large the FX market is in volume?

Foreign Exchange Market

It is the world's largest market, with approximately
6,600,000,000,000 USD
traded per day (BIS 2016 estimate).

Outline

Foreign Exchange Market Structure - Overview

Some of the distinctive characteristic of the FX market are the following.

- It operates **24 hours a day, 5 days a week**.
- It is **decentralised**, which means that there can be several competing prices for a given asset.
- Its **main hub is London**, other major hubs are New York and Hong Kong (*NyLonKong*).
- The most traded currencies are the US Dollar (USD), the Euro (EUR), the Japanese Yen (JPY) and the British Pound Sterling (GBP).

Foreign Exchange Market Structure - Overview

- For most currencies, the most liquid contract is the **spot**. It usually corresponds to a maturity of T+2 (business days).
- All sorts of contracts are traded in the FX market: both OTC or exchange traded.
- Most notably, the swaps market is very large.

Foreign Exchange Market Structure - Jargon

There is a lot of jargon used in FX. Some notable examples.

- The currency pair GBPUSD is called 'cable'.
- Most major currency pairs have their own nickname, such as the 'kiwi' (NZDUSD) or the 'nokkie' (EURNOK).
- Local markets have their own jargon, based on local conventions. Most notably, the Brazilian market quotes actively the points between the spot and the first future contract, called 'casado' ('married' in Portuguese).

Foreign Exchange Market Structure - Structure

- A small groups of banks make up the interbank foreign exchange market.
- Structurally, it is therefore a **brokerage** market. It means that the end users will not directly transact with each other.
- End users comprise companies, governments, pension funds, etc. The retail market is very small in comparison to the wholesale market.
- FX is a key component of **macro trading**.

Foreign Exchange Market Structure - Structure

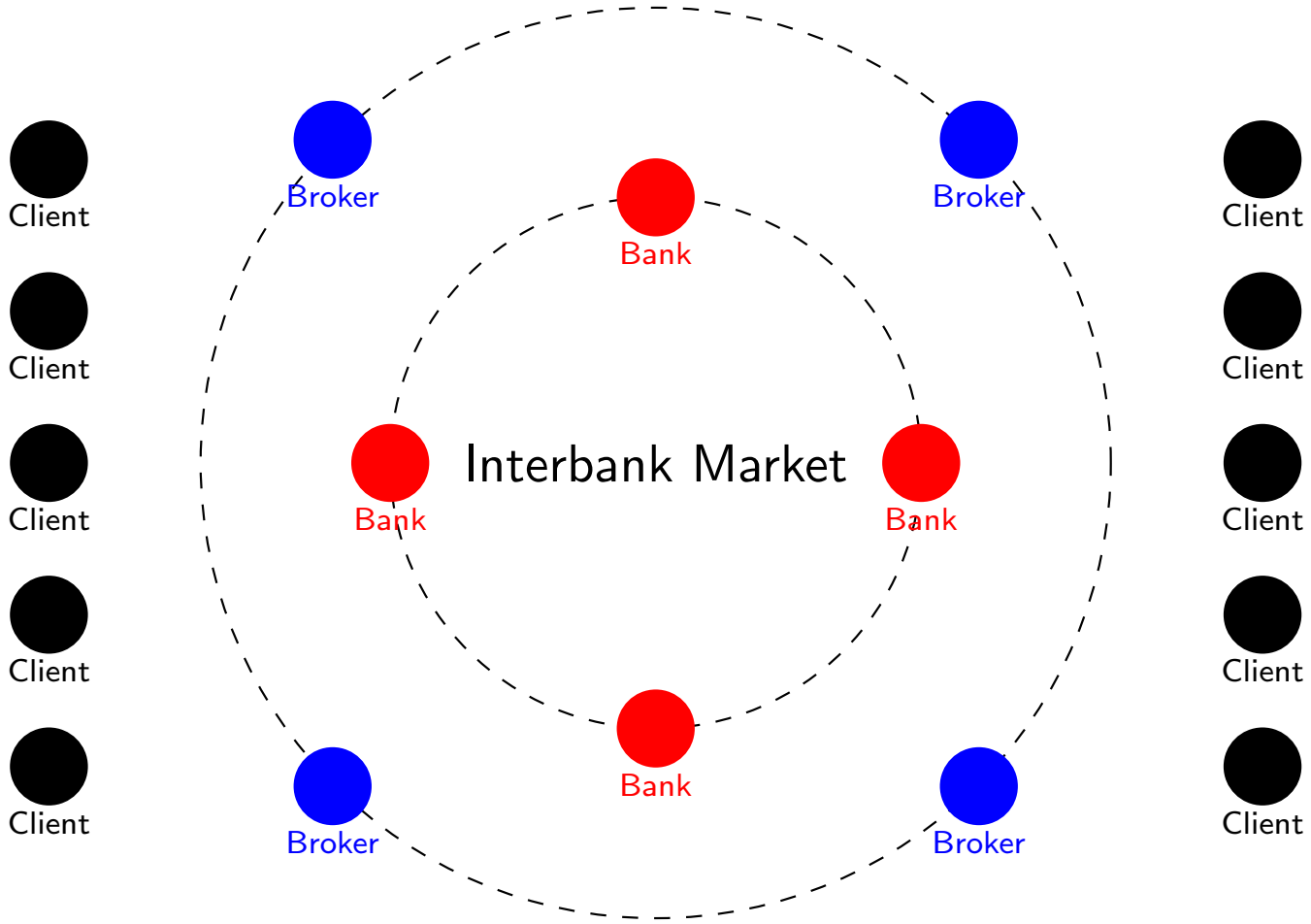

Figure: FX Market Structure

Foreign Exchange Market Structure - Structure

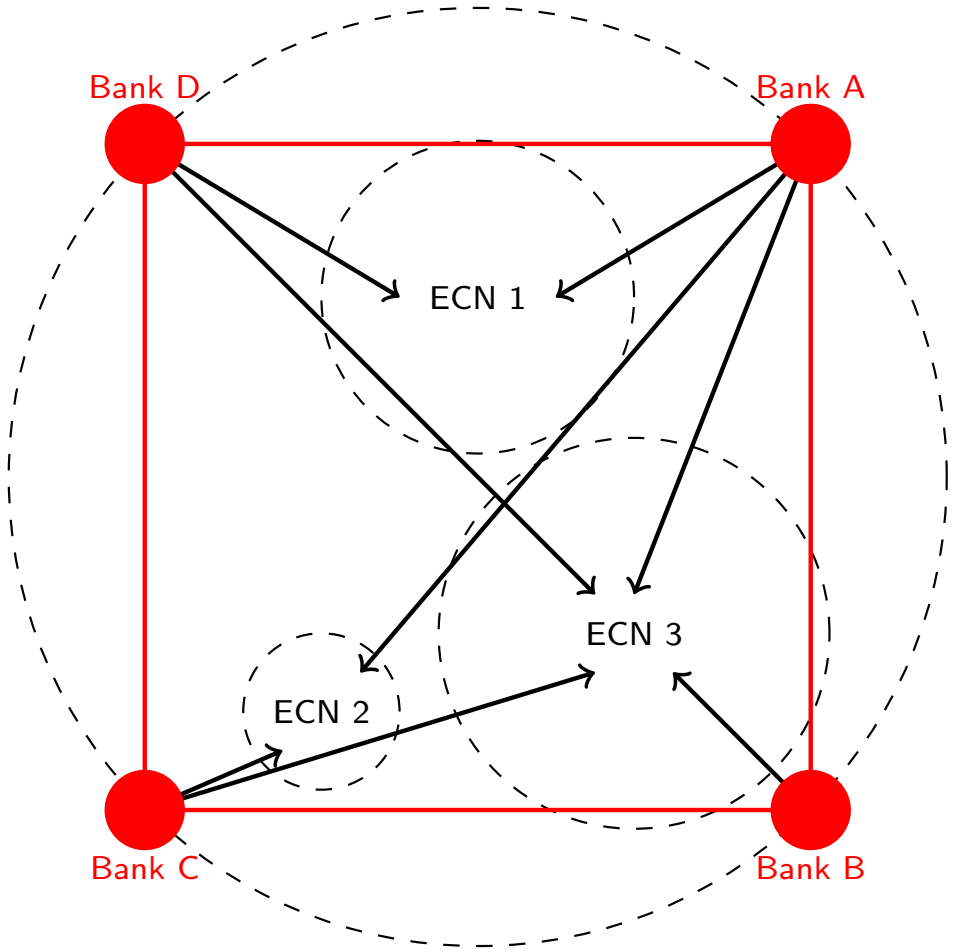

Figure: eFX Interbank Market Structure

Foreign Exchange Market Structure - Structure

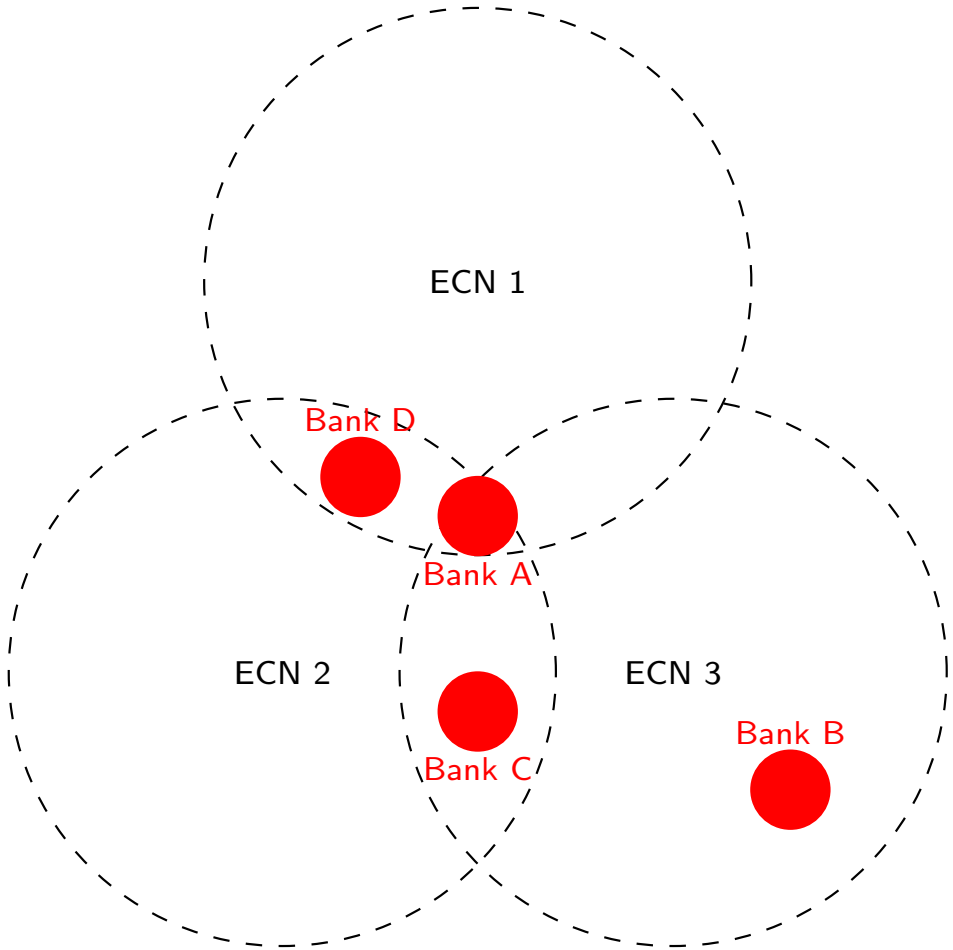

Figure: eFX Interbank Market Structure - Fragmentation

Outline

Liquidity Fragmentation

- In the previous section, we have observed that the interbank market was decentralised.
- There are different venues for eFX trading. The largest ones are EBS and MAPI.

Liquidity Fragmentation

Definition (Liquidity Fragmentation)

Liquidity fragmentation is the quality of liquidity being split across non-intersecting liquidity pools.

- Those different liquidity pools might be, but are not only, different venues.
- Market participants try to optimise how much orders must be split to access liquidity in the shortest amount of time [4] and with the lowest market impact.

Liquidity Fragmentation

Liquidity fragmentation can be measured using the concept of entropy (Physics).

Definition (Fragmentation Efficiency Index)

Lehalle and Laruelle [4] introduce the FEI, with N the number of venues and $\mathfrak{M}_n$ the market-share of venue n.

$$H = -\frac{1}{\log N} \sum_{n=1}^{N} \mathfrak{M}_n \log \mathfrak{M}_n$$

Liquidity Fragmentation

Conjecture (Market Fragmentation)

A given market's fragmentation will increase with time, at a decreasing rate.

- When markets become more mature, multiple ECNs will enter the market. They will compete for volumes and grow with the market.
- As the market grows more slowly, and as margins become tighter, there are fewer new participants and the fragmentation stabilises.

It also means that as practitioners, we perceive fragmentation as a **one-way road**.
However, the above is not true in terms of number of market participants.

Liquidity Fragmentation - Characteristics: Venues

One of the most common forms of fragmentation is at the venue level.

- **Tick Size** Large ticks have larger queues for transactions, but favour low-latency traders [4].
- **Order Types** Different venues operate different order types. Some features advantage certain market participants, *e.g. iceberg orders favour liquidity providers*.
- **Data** Venues have different levels of transparency with regards to orderbook date (update frequency) and trades.

Liquidity Fragmentation - Characteristics: Latency

- In a geographically decentralised market, the information about liquidity does not travel instantaneously.
- Most data centres for trading are in New York, London and Tokyo.
- Market participants will try to colocate their trading systems to minimise latency to each data centre.
- Venues provide orderbook snapshots at regular intervals (couple of ms).

Latency is a form of fragmentation, as not all market participants (if any) can have the same information about available liquidity at any given point in time.

Liquidity Fragmentation - Characteristics: Latency

Theorem (Shannon's Theorem)

If a function $x(t)$ contains no frequencies higher than B hertz, it is completely determined by giving its ordinates at a series of points spaced $1/(2B)$ seconds apart.

Lehalle and Laruelle [4] extrapolate the above to HFT in the form of the latency bound, below which any HFT trader **must** be to have complete orderbook information.

Definition (Nyquist-Shannon Latency Bound)

$$NS\ Latency\ Bound = \frac{1}{2}\frac{1}{orderbook\ update\ frequency}$$

Liquidity Fragmentation - Characteristics: Counterparties

- In a decentralised market, counterparties trade against each other.
- There are constraints about which counterparties can trade with each other. This is true in particular for swaps.
- A key limitations is the existence of a **credit line** agreement between the two counterparties.

As a result, two conterparties using the same ECN might not be able to trade with each-other because of those rules. This means that some liquidity might be visible, while remaining inaccessible. The latter is also referred to as **credit-screened liquidity**.

Liquidity Fragmentation - Occurrences

- Fragmentation is ubiquitous in FX, but is very complex in nature and difficult to quantify.
- It is very well studied and documented for stocks [4].
- Examples of fragmentation are the EBS / MAPI duopoly for G10, or the ON/OFF SEF venues (Dodd-Frank Act) for some Asian currencies.

While fragmentation is most often a qualitative property, it has quantitative implications.

Outline

Implications of Liquidity Fragmentation

Some key implications of liquidity fragmentation can be found in different aspecs of quantitive research on an electronic trading desk.

3 Implications of Liquidity Fragmentation
- Alpha Implications
- Pricing Implications
- Execution Implications

Liquidity Fragmentation - Alpha

- Very short term alphas rely on market microstructure observables, such as **order book imbalance**. In a fragmented market, such observable is difficult, if not impossible to compute.
- Medium and long term alphas rely on **efficient market hypothesis** on information (EMH). Those hypothesis are also broken n fragmented markets [5].

Some commonly used workarounds are to select a reference liquidity pool, or a set of pools; and to run assumptions when designing alphas. Those assumptions are tested continuously throughout the life-cyle of the alpha.

Liquidity Fragmentation - Pricing

Similarly to alpha generation, the fact the EMH does not hold creates complications to the pricing process. Different methodologies are in use.

- **Primary Reference** One liquidity pool is used as the sole reference for pricing. This is only possible where the FEI is very low.
- **Aggregation** Pricing is derived from multiple venues, by combining observed liquidity as if it was one pool. This does not hold when the exchange characteristics differ too much, typically tick size [4]. Some arbitrage might arise [3].
- **Combination** Non-naive aggregation, whereby contributions of different venues are adjusted.

Usually, pricing is the first piece of the electronic risk management pipeline, and is therefore critical to both alpha and execution.

Liquidity Fragmentation - Execution

- One of the key contributions to modern quantitative finance execution theory is the Almgren-Chriss framework (ACF) [1][3]. The model introduces the concept of an efficient frontier for optimal execution, in the Markowitz sense (Expected loss / Risk).
- Previous notable models, such as Bertsimas Lo [2], do not take into account liquidity. Results of the ACF are that lower rates of execution are desirable where there is thinner liquidity.
- The framework introduces a temporary market impact component ($h(.)$), which is much more difficult to modelise in a fragmented market, as the impact function is not linear with the rate of trading.

Bibliography


Robert Almgren and Neil Chriss.
Optimal execution of portfolio transactions.
Journal of Risk, 3:5–40, 2001.


Dimitris Bertsimas and Andrew W Lo.
Optimal control of execution costs.
Journal of Financial Markets, 1(1):1–50, 1998.


Olicier Gueant.
The Financial Mathematics of Market Liquidity - From Optimal Execution to Market Making.
Chapman & Hall / CRC Financial Mathematics Series, 2016.


Charles-Albert Lehalle and Sophie Laruelle.
Market Microstructure in Practice - Second Edition.
World Scientific, 2018.

Thank you! :-)